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Sequence Component Surges of Three Phase Line when Phase-A is Switched by Unit Step Voltage

G. P. Chhalotra[1], A. B. Singh[2], Brijesh Singh[3], Manisha Chhalotra[4], Rajendra Kumar Varandani[5] and Mehmood Qadir[6]

[1]Former Dean,
Govt. Engineering College, Jabalpur, M.P., INDIA.
[2]Senior Computer Programmer,
G.D. University, Bilasput, C. G., INDIA.
[3]Registrar,
A.P.S. University, Rewa, M. P., INDIA.
[4]Atharwa Institute of Management, Bombay, M. S., INDIA.
[5]Dean Senior Students,
S.I.R.T. Bhopal, M.P., INDIA.
[6]Lecturer,
Govt. Nishatpura H. Sc. School, Bhopal, M. P., INDIA.

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ABSTRACT

Fuzzy logic is well known to all the researchers. It is a set theory of its kind and universal method of transformation of uncertain problems Here we have developed a new method to solveSequence Component Surges of Three Phase Line when Phase-A is Switched by Unit Step Voltage.

Keywords: Surges, Unit-Step Voltage.

I. INTRODUCTION

Sequence components are three voltages transformed from ABC components when are mutually coupled. It is well known that three phase lines are always designated by ABC or RYB in the electrical power houses. There is a line of ground May be a returned path. We cannot neglect the ground on which the transmission lines are installed.

There are several types of components to transform the line impedances intoZ_1, Z_2 and Z_0 called positive, negative zero sequence components. If we use the symmetrical components use have the currents I_1,I_2 and I_0 as surges and V_1,V_2 and V_0 voltages such that

$$Z_1 = \frac{V_1}{I_1}, Z_2 = \frac{V_2}{I_2} \text{ and } Z_0 = \frac{V_0}{I_0} \qquad (1.1)$$

As the well known Ohm's law. There are $\alpha\beta o$ components well known in the literature. Our purpose is to study the electrical surges using the component surges and travelling waves for fuzzy domain system. The reliability is the major problem of three phase line problem.

One can determine the reliability through fuzzy domain. The modern practice is to study the reliability under the cries problems. We study the surges of λ μo and ρσo or $\alpha\beta o$ which are slightly different to other in the analysis of phase-A, phase-B and phase-C. We May introduce a little about these components. In the $\alpha\beta o$ component the surges.

A-g, Bc and Bc-g become symmetric (1.2)

In the λ μ_o the surges are as follows:

B-g AC and AC-g become (1.3)

symmetric and less work is involved in the calculations and on digital computer require less storage and space.

The ρσois advantageous for surges C-g, AB and AB-g (1.4)

We will develop the fuzzy equations for these transactions in surge domain. Impedance is same but one can call them

$$\left.\begin{aligned} Z_\alpha &= \frac{V_\alpha}{I_\alpha},\ Z_\beta = \frac{V_\beta}{I_\beta},\ Z_0 = \frac{V_0}{I_0} \\ Z_\lambda &= \frac{V_\lambda}{I_\lambda},\ Z_\mu = \frac{V_\mu}{I_\mu},\ Z_0 = \frac{V_0}{I_0} \end{aligned}\right\} \qquad (1.5)$$

$$Z_\rho = \frac{V_\rho}{I_\rho},\ Z_\sigma = \frac{V_\sigma}{I_\sigma},\ Z_0 = \frac{V_0}{I_0} \qquad (1.6)$$

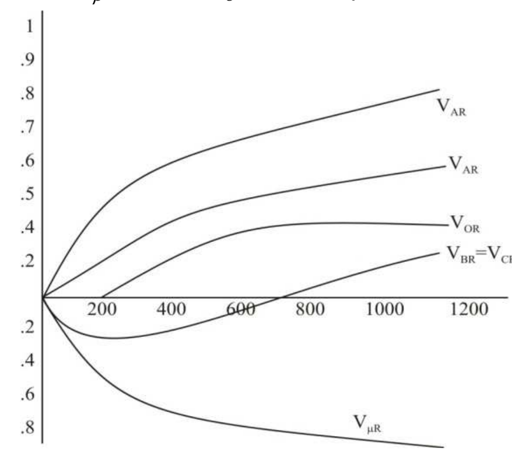

Fig.1.1 $\lambda\mu_0$ Surges of Three Phase Electrical Line

II. TRANSFORMATION OF $\lambda\mu_0$ SURGES AND THEIR FUZZIFICATION

Fig. 1.1 represents the $\lambda\mu_0$ surges using the erfc(x), in the time domain t and voltages in the distance x for a 300km long line.

TABLE 2-1 λ -surge

X	50	100	150	200	300	400	500	600	700	800
μ(x)	.1	.2	.3	.39	.49	.55	.60	.62	.65	.66

We have to find the fuzzy cardinality and the relative fuzzy cardinality as follow:

$$|\overline{A}| = \int_0^x \mu(x)dx = 4.56,\ x = 8 \qquad (2.1)$$

and $$\left\|\overline{A}\right\| = 0.456,\ x = 8 \qquad (2.2)$$

We can call a proportional to the reliability. This May be a fuzzy reliability.

One can fuzzify the time as given above from 50 μs to 800 μs as follows:

(0.0625, 0.125, 0.1875, 0.25, 0.375, 0.50, 0.625, 0.875, 1) (2.3)

For the time set we have

$$\left|\overline{A}\right| = \int_0^x \mu(x)dx = 2.965 \quad (2.4)$$

$$\left\|\overline{A}\right\| = 0.3705$$

Surge intersection will be:
Min $0.475 \cap 0.375 = 0.375$ (2.5)
The union would be:
Max $0.475 \cup 0.375 = 0.475$ (2.6)
The conjugate of the intersection May be:
Min $0.525 \cap 0.626 = 0.525$ (2.7)
The complementary function of the surges domain of table 5-1 would be:

μ(X) c= (0.9, 0.8, 0.7, 0.81, 0.51, 0.45, 0.40, 0.38, 0.35, 0.34) (2.8)
The cardinality would be:
|Ā|= 5.64
The relative fuzzy cardinality
||Ā||= 0.564

III. FUZZINESS IN THE λ -WAVE

We write the set-A for the surges and its complementary or dual function set A_c

$$\left.\begin{aligned} Set\ A &= (0.1, 0.2, 0.3, 0.39, 0.49, 0.55, 0.60, 0.60, 0.65, 0.66) \\ Set\ A_C &= (0.9, 0.8, 0.7, 0.81, 0.51, 0.45, 0.40, 0.38, 0.35, 0.37) \end{aligned}\right\} \quad (3.1)$$

$$\left.\begin{aligned} Min\ A \cap A_C &= (0.1, 0.2, 0.3, 0.39, 0.49, 0.45, 0.40, 0.38, 0.35, 0.34) \\ Max\ A \cup A_C &= (0.9, 0.8, 0.7, 0.81, 0.51, 0.55, 0.60, 0.62, 0.65, 0.66) \end{aligned}\right\} \quad (3.2)$$

$$\left.\begin{aligned} \left\|\overline{A}\right\| &\Rightarrow A \cap A_C = 3.78 \\ \left\|\overline{A}\right\| &\Rightarrow A \cup A_C = 6.79 \end{aligned}\right\} \quad (3.3)$$

The fuzziness in the λ wave May be as follows :

$$E(x) = \frac{A \cap A_C}{A \cup A_C} = \frac{3.78}{6.79} = 0.556 \quad (3.4)$$

E, Entropy= 55.6% (3.5)

Fuzziness is very clear which we cannot calculate visualize and observe easily and with simple manner.

The fuzziness in the time set May be as follows:
Set A= (0.0625, 0.125, 0.1875, 0.25, 0.375, 0.50, 0.625, 0.875,1)
Set A_c= (0.9375, 0.875, 0.8125, 0.75, 0.635, 0.50, 0.375, 0.1250) (3.6)
Min $A \cap A_c$ = (0.0625, 0.125, 0.1875, 0.25, 0.375, 0.5, 0.375, 0.125,0)
Max$A \cup A_c$= (0.9375, 0.875, 0.8125, 0.75, 0.625, 0.50, 0.625, 0.875, 0.1) (3.7)
$A \cap A_c$ (|Ā|) =fuzzy cardinality
$|A \cap A_c|$ =2.375
(3.8)
$|A \cup A_c|$ =7.0

Fuzziness = E = $\frac{2.375}{7} = 0.3392$ (3.9)

The wave has more fuzziness than the time set as clear that time digits are not coupled while surges are coupled to the interaction at each step of the time.

IV. FUZZIFICATION OF THE WAVE $V_{\mu R}$

The $\boldsymbol{\lambda}_{\mu o}$ wave are plotted in Fig 1.1 with the functions ercf(x). the x wave is analyzed whose results are given above in the concrete from of the fuzziness of surge and time. We can analyze the μ-wave as follows:

TABLE 4.1

x	25	50	90	200	300	400	500	600	700
μ(x)	.1	.2	.3	.431	.432	.433	.434	.431	.434

We can write the fuzzy set as follows:

μ(x)=(0.1, 0.2, 0.3, 0.431, 0.432, 0.432, 0.433, 0.434, 0.431, 0.434) (4.1)

μ(x)$_c$=(0.9, 0.8, 0.7, 0.569, 0.568, 0.567, 0.566, 0.569, 0.566) (4.2)

The fuzzy cardinality would be:

$$\left.\begin{aligned} |\mu(x)| &= 3.195 \\ |(\mu_x)_c| &= 5.805 \end{aligned}\right\} \quad (4.3)$$

$$\left.\begin{aligned} &\mu(x)\cap\mu(x)_C = (0.1, 0.2, 0.3, 0.431, 0.432, 0.433, 0.434, 0.431,\ 0.434) \\ &\text{Cardinality would be } 3.195 \end{aligned}\right\} \quad (4.4)$$

μ(x) $\cup$ μ(x)$_c$=(0.9, 0.8, 0.569, 0.567, 0.566, 0.569, 0.564, 0.566) (4.5)

Cardinality of union would as follows:
The fuzziness would be as follows:

$$E(x)=\frac{3.195}{5.805} = 0.55038 \quad (4.6)$$

The Zero sequence components remain the same in all the system. We have studied the $012, \alpha\beta_0, \lambda\mu_0$ and $\rho\sigma o$ components. This is a system of transformation which can make the wave simple.

V. THE $\rho\sigma o$ COMPONENTS

We pointed out that there are three sets of components in the three phase networks. One type λμo are described above. The $\rho\sigma o$ are now explained for the surges C-g, AB and AB-g to be symmetric in nature.

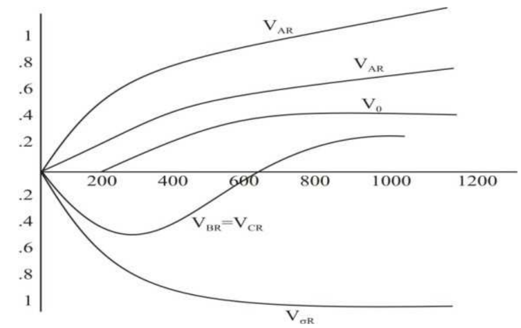

Fig 5.1 Surges $\rho\sigma o$ at the Receiving End of The Line.

μ (x)=(0.1, 0.2, 0.3, 0.35, 0.36, 0.37, 0.4, 0.45, 0.5, 0.55, 0.56) (5.1)

μ (T)=(200,400,600,800,1000,1200)
μ (Tx)=(0.166, 0.333, 0.5, 0.666, 0.833, 0.1) (5.2)

The surge μ(x) of ρ is clearly found as follows

$\mu_{x\rho}$ =(0.1,0.2,0.3,0.35,0.36,0.37,0.4,0.45, 0.5,0.55,0.56) (5.3)

Complimentary function of $\mu_{x\rho}$ would be

$\mu_{(x\rho)c}$ =(0.9,0.8,0.7,0.65,0.64,0.63,0.6,0.55, 0.45,0.44) (5.4)

|A|=4.14=$(\mu_{x\rho})$ (5.5)

|A|$_c$=6.36= $\mu_{(x\rho)c}$

One can find the union and the intersection of the two sets $\mu_{x\rho}$ and $\mu_{(x\rho)c}$ as follows:

$$\left.\begin{array}{l} \mu_{x\rho} \overset{\max}{\cup} \mu_{x\rho c} = (.9,.8,.7,.65,.64,.63,.6,.55,.55,.56) \\ \mu_{x\rho} \underset{\min}{\cap} \mu_{x\rho c} = (.1,.2,.3,.35,.36,.37,.4,.45,.5,.45,.44) \end{array}\right\} \quad (5.6)$$

The cardinality of the union and intersection would be as follows:

$$\left.\begin{array}{l} \mu_{x\rho} \overset{\max}{\cup} \mu_{x\rho c} = 6.68 \\ \text{and} \\ \mu_{x\rho} \underset{\min}{\cap} \mu_{x\rho c} = 3.98 \end{array}\right\} \quad (5.7)$$

The fuzziness in the surge V_{PR} is as follows:

$$E(x)_1 = \frac{3.98}{6.68} = 0.5868 \quad (5.8)$$

Now we consider the $\mu_{(T)}$ and $\mu_{(Tx)}$ as follows for the fuzziness :

$\mu_{(Tx)}$=(.166, .333, .5, .666, .833,1) (5.9)

Its complimentary function will be

$\mu_{(Tx)c}$=(.834,.667,.5,.334,.167,0) (5.10)

There are six elements the cardinality of the $\mu_{(Tx)}$ and $\mu_{(Tx)c}$ are as follows:

$$\left.\begin{array}{l} |\mu_{(Tx)}| = 3.498 = \text{cardinality} \\ |\mu_{(Tx)c}| = 2.502 = \text{cardinality} \end{array}\right\} \quad (5.11)$$

We develop the union and the intersection by simple method as alone above for the surges in equation (5.36).

$$\mu_{(xT)} \overset{\max}{\cup} \mu_{(xT)c} = (.834,.667,.5,.666,.833) \quad (5.12)$$

$$\mu_{(xT)} \underset{\min}{\cap} \mu_{(xT)c} = (.166,.333,.5,.334,.167,.0) \quad (5.13)$$

Their cardinality would be as follows:

Max $\cup$= 4.9 (5.14)

Min $\cap$=1.499 (5.15)

$$E(x)_2 = \frac{1.499}{4.9} = 0.306 \quad (5.16)$$

Fuzziness in the V_{PR} wave for the time domain elements. The average fuzziness will be

$$\frac{E(x)_1 + E(x)_2}{2} = \frac{0.5868 + 0.306}{2} \quad (5.17)$$

$$E(x)_3 = 0.4464 \quad (5.18)$$

VI. VOLTAGE $V_{\sigma R}$the σ-WAVE

The sigma wave is negative in the plane but we consider its cardinality and fuzziness of the wave by forming fuzzy set as follows:

$\mu(\sigma x)$=(0,.1,.2,.3,.4,.45,.5,.6,.7,.8)=A (6.1)

Assuming these as the fuzzy member4s using from 0 to 1, we May find its cardinality as follows:

$|\mu(\sigma x)|$=4.35 (6.2)

As the elements are 10 in numbers the cardinality May be changed to the relative as above:

$\|\mu(\sigma x)\|$=0.435= reliability (6.3)

Now we develop the fuzziness in the wave as compared to other wave. One can compare and contract the surges:

$\mu(\sigma x)c$=(.1,.9,.8,.7,.6,.55,.54,.3,.2)=A_c (6.4)

Finding the union and intersection of the two sets as A and Ac as the case would be:

$A \cup A_c$=(.1,.9,.8,.7,.6,.55,.5,.6,.7,.8) (6.5)

$A \cap A_c$=(0,.1,.2,.3,.4,.45,.5,.4,.3,.2) (6.6)

The cardinality would be, we avoid the large symbols and convert them simple one as

|Ā| $A \cup Ac$= Ā=7.15 (6.7)

$A \cap Ac$= Ā=2.85 (6.8)

Fuzziness in the wave would be

$$E(x) = \frac{2.85}{7.15} = 0.3986 \quad (6.9)$$

In the ρ-surge there is more fuzziness as compared to the σ surge. In the

r-surge the fuzziness in all the surges that can be added to the surge function.

VII. ZERO SEQUENCE SURGE

We have simulated V_1, V_2 and V_0 surges in a three phase power system. We encounter the current I_1,I_2 and I_0, with the impedances Z_1, Z_2 and Z_0 voltages:

$$\left.\begin{aligned} V_1 &= I_1 Z_1 \\ V_2 &= I_2 Z_2 \\ V_0 &= I_0 Z_0 \end{aligned}\right\} \tag{7.1}$$

We can simulate this curve using the mathematical methods develop for the surges.

$\mu(x)=(0,.1,.2,.3,.4,.5,.6,.7,.8)$ (7.2)

The fuzzy cardinality would be

$|\bar{A}|=|\ \mu(x)|=3.6$ (7.3)

Element number x=9

$$\|\bar{A}\|=\frac{3.6}{9}=0.4 \tag{7.4}$$

This May be the Reliability of the surge at the surge arrester. The graphs varies from 0 to 1 and any arbitrary fuzzy numbers May be approximated according to the fitness of the surges and mathematical equations developed for this purpose referring equation (2.1) and (2.2), we can explain as the positive sequence voltage V_1, current I_1 and impedance Z_1.

For the fuzziness of the zero sequence surges we develop the complimentary function of equation (5.50)

$\mu(x)_c= (1,.9,.8,.7,.6,.5,.4,.3,.2)$

The union and the intersection would be

$\mu(x) \cup \mu(x)_c =(1,.9,.8,.7,.6,.5,.4,.7,.8)$

And the magnitude would be; 6.6

The intersection will be:

$\mu(x) \cap \mu(x)_c=(0,.1,.2,.3,.4,.5,.6,.4,.3,.2)$

And magnitude will be: 3.0

Fuzziness$=\frac{3.0}{6.6}=0.4545$

Zero sequence surges have greater fuzziness as compared to r and s surges.

VIII. FUZZY SPACE

We can understand the fuzziness in the ABCD square as follows in Fig.5.3 we can select the point's greater fuzziness and duals or complementary points:

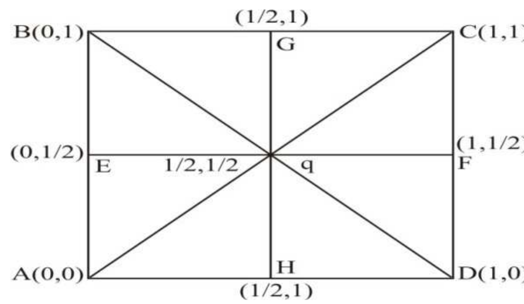

Fig.8.1 Point of Greater Fuzziness

A and C are duals points

B and D are duals points

E and F are duals points

G and H are duals points

Cardinality of points will be:

Cardinality	Relative	Cardinality
A(0)	0	0
B(1)	1/2	.5
C(2)	1	1
D(1)	1/2	.5
E(1/2)	1/4	.25
$F\left(1\frac{1}{2}\right)$	.75	.75
$G\left(1\frac{1}{2}\right)$	.75	.75
H(1/2)	1/4	.25
q(1)	1/2	.5

Centre point q $\left(\frac{1}{2},\frac{1}{2}\right)$

Set A= $\frac{1}{2},\frac{1}{2}$

Set Ac = $\frac{1}{2},\frac{1}{2}$

A$\cup$Ac = $\left(\frac{1}{2},\frac{1}{2}\right)$ =>1

A$\cap$Ac = $\left(\frac{1}{2},\frac{1}{2}\right)$ = Fuzziness = 1= 100%

Point A (0, 0) has a fuzziness 0 point B (0, 1)
Set A=0, 1
Set Ac=1, 0
A$\cap$Ac= (0, 0) ≡0
A$\cup$Ac= (1, 1) ≡2

Fuzziness = $\frac{0}{2}$ =0=E(x)
Point (1, 1)
Set A=1, 1
Set Ac=0, 0
A$\cup$Ac= (1, 1) ≡2
A$\cap$Ac= (0, 0) ≡0
E = $\frac{0}{2}$ =0

The centre point q has a largest fuzziness E(x)=1

Point D (1, 0)
Set A = (1, 0)
Set Ac = (0, 1)
A$\cap$Ac= (0, 0) ≡0
A$\cup$Ac= (1, 1) ≡ 2, $\frac{0}{2}$ =E(x)

Point E $\left(0,\frac{1}{2}\right)$

Set A = $0,\frac{1}{2}$

Set Ac = $1,\frac{1}{2}$

A$\cap$Ac = $\left(0,\frac{1}{2}\right) \equiv \frac{1}{2}$

A$\cup$Ac = $\left(1,\frac{1}{2}\right) \equiv 1\frac{1}{2}$

$$E = \frac{0.5}{1.5} = 0.333$$

Point F $\left(1,\frac{1}{2}\right)$

Set A = $1,\frac{1}{2}$

Set Ac = $0,\frac{1}{2}$

A$\cap$Ac = $\left(0,\frac{1}{2}\right) = \frac{1}{2} = 0.5$

A$\cup$Ac = $\left(1,\frac{1}{2}\right)$=1.5

$$E = \frac{0.5}{1.5} = 0.333$$

DISCUSSION

A system is general simulation of a group of work, where input and output are realized and system parameters play a vital role to give the required output and modifies the input. The appropriate location of a

system in the demand and supply field is a problem of this study. Most uncertain problems can be solved using Fuzzy logic techniques. One can find the reference phases and origin of the random system. The Fuzzy cardinality and relative Fuzzy cardinality can solve such problems, one can find the objective and constraint of the elements and a Fuzzy decision can be found. Constraint may be a dual or inverse of the objective.

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